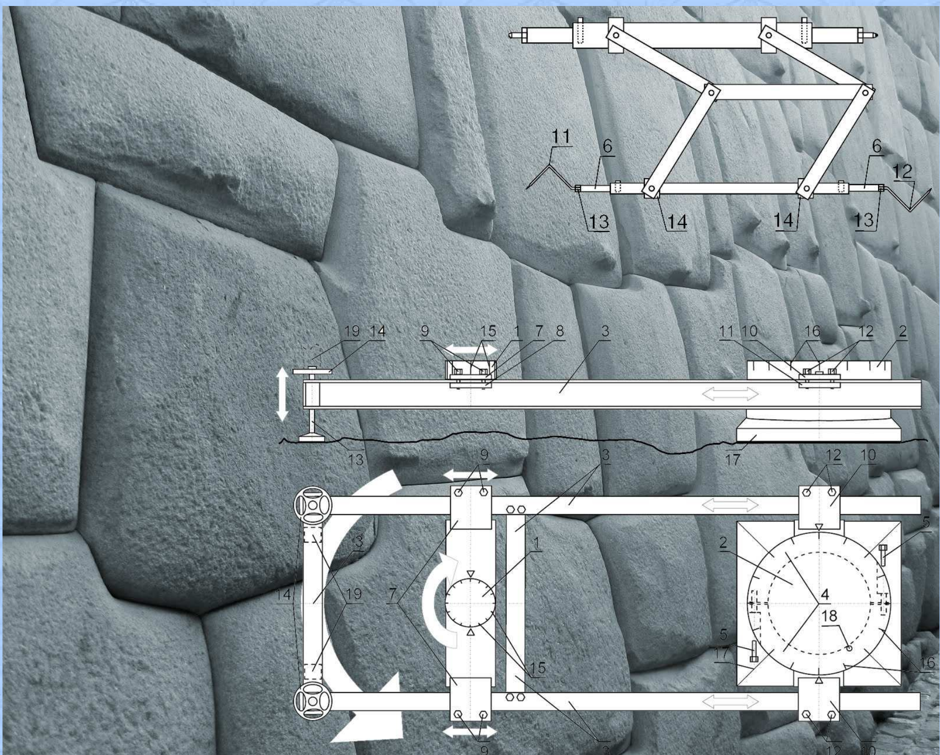
R. V. Lapshin

Peruvian polygonal masonry
how, who, when and what for



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The monograph covers the problem of reproduction of the most complicated for implementation type of a polygonal masonry existing in Peru using simplest means. This masonry type consists of large stone blocks weighing from several hundred kilograms to several tons fitted almost without a gap between complicated curved surfaces over a large area. The proposed methods are based on the use of a reduced clay model, 3D-pantograph, topography translator and replicas.

The Fortress Sacsayhuaman has been identified as a survived to our time example of early star fortresses. The polygonal structures in Peru, the polygonal Face Towers and polygonal bas-reliefs in Cambodia, the symmetrical and geometrically similar statues of pharaohs in Egypt are based on the alike construction technologies, working methods, tools and technical contrivances. All these monuments were created by people belonging to the same European group (guild) of architects, sculptors, builders and could not have appeared earlier than the 17th century – the time of invention of a 2D-pantograph. Besides the technical and processing aspects related to the polygonal masonry, the book provides an explanation of the base of the Peruvian economy of the time of the large-scale megalithic construction prosperity on its territory, as well as the purpose of this construction.

Analysis of the “tired” stones in Ollantaytambo, the unfinished Obelisk in Aswan and the Baalbek monoliths has shown that all of these “incredibly ancient monuments” are fakes. The book explains in detail how and with what tools the unfinished Aswan Obelisk was actually formed. Analysis of the symmetry and fabrication process of the Queen Nefertiti bust has shown that the world-famous bust is a forgery. At the end of the book, a hypothesis is put forward regarding the functional purpose of the “mysterious” Sabu disk, which has been exciting the minds of Egyptologists around the world for decades.

The book is intended for a wide range of readers interested in the topic of the polygonal masonry. A general engineering education is necessary to understand some issues. The book will be useful to mechanical engineering and civil engineering students seeking to expand their horizons.

Figs. 22, photos. 87, ills. 2, refs. 148.

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1. Introduction

Polygonal masonry is a type of masonry made of natural stone. Stones having an initially arbitrary shape are processed in such a way that form irregular polygons tightly adjacent to each other on the front side of the structure.[1] It should be noted that the name "polygonal masonry" is largely conditional. The fact is that there are many structures classified as polygonal in which stone "polygons" have curved sections besides the linear ones. A feature of the polygonal masonry is that it does not require a building mortar (dry masonry). The polygonal masonry possesses sufficient strength and stability to withstand moderate earthquakes.[2,3,4,5]

In the present monograph[a], a polygonal masonry in the megalithic structures located on the territory of modern Peru is under consideration. The main attention is paid to the masonry consisting of large stone blocks weighing from several hundred kilograms to several tons fitted close to each other almost without a gap between curved surfaces of large area (see Photos. 2.1-2.16, 2.18). The remaining simpler types of the polygonal masonry, when the stones are small[6] or the mating surfaces are almost flat,[6,7] or the stones contact each other over a small area,[7] or there are significant gaps between the stones,[8] are quite correspond to the long-known methods of the stone processing and, therefore, they do not require any special explanation.

If we understand how the Peruvian polygonal masonry was made, it becomes clear who created the structures based on it and when. When it is clear who and when, then it is possible to figure out why these structures were needed, what they served for. One should clearly understand that something can be built only when there are: necessary materials, tools, contrivances, proven technologies (methods), and trained, knowledgeable people. Therefore, no written sources of medieval eyewitnesses, travelers, chroniclers with stories, memories, evidences, etc. about how, who, when and why built the megalithic structures in Peru of the polygonal masonry are worth nothing if the human society of the time under description did not have at that moment the corresponding materials, tools, contrivances, technologies, and staff (architects, builders) of appropriate knowledge and experience, able to use all of the above. The absence of at least one of these components makes the polygonal construction of the considered type impossible.

1.1. Design features of the dry polygonal masonry

Since mortar is not used in the polygonal masonry, to ensure integrity of a structure, significant static friction forces should act in addition to the mechanical locking between the stone blocks of the masonry. The static friction force depends on the stone-by-stone static friction coefficient, weight of the stone block and the microrelief in the contact area of the surfaces. Since the friction coefficient is determined mainly by the properties of the used material, it cannot be changed for chosen rock. Although the contact area does not affect the value of the static friction force practically, nevertheless, its increasing (especially between the horizontal faces of the blocks) allows to distribute the block weight more evenly without using mortar that reduces local stresses and thus decreases a probability of wall cracking and stone crushing.

In the long term, a large contact area can provide effective mineralization (filling) of the gap in the contact area with penetrating aqueous mineral solutions (see Sec. 3.3), which further increases the strength, cohesion, and stability of the masonry. It is known that with equal adherence to all other requirements, the thinner the mortar layer, the stronger the masonry with mortar.[9] Thus, the type of the polygonal masonry under consideration, in which the minerali-

[a] Most of the material in the book is based on the author's article "Fabrication methods of the polygonal masonry of large tightly-fitted stone blocks with curved surface interfaces in megalithic structures of Peru" (Preprints.org, no. 2021080087, 66 pp., 2024, DOI: 10.20944/preprints202108.0087.v10) published in the form of preprints in the period 2021-2024.

zation (monolithing) of the gap between the stones tightly adjacent to each other takes place, provides maximum strength of the masonry and, in this regard, brings it closer to the theoretical strength limit. The only thing that cannot always be reached in such masonry is a good bonding[9,10] of the blocks due to widely varying shape and sizes of the used stone blocks.

Regarding the mentioned block bonding, it is also worth noting the following. Often, researchers of megaliths, seeing such a natural formation as joints,[11] mistakenly take it for a polygonal masonry. The main feature that distinguishes the joints from a polygonal masonry is the absence of a bonding of the stone blocks. The joints divide a rocky outcrop into a system of posts – blocks of the same length and width lying one on the other exactly.

Sometimes, the layers of the upper part of the joints displace relative to each other due to tremors and/or a slope of the rock outcrop. Such displacement (sliding) can lead to a mutual position of the blocks resembling the bonding. Nevertheless, it is not difficult to distinguish the natural joints from a man-made masonry even in this case. The point is that the underlying layers retain the original post structure of the joints. Moreover, if we mentally return the displaced layers to their original position, the contours of the adjacent blocks in the resulting posts would completely coincide.

Obviously, the larger the vertical size of the stone blocks, the smaller is the number of courses of the polygonal masonry for a given wall height. Moreover, it is known that increasing the height of a stone block increases its bending resistance abruptly (in proportion to powers of two).[9] As a result, those polygonal masonry turns out to be stronger which stone blocks have a greater height. Thus, to achieve the high strength and stability of the polygonal structure, it is necessary to use as heavy, large, and sufficient height stone blocks as possible, maximize the contact area between the adjacent blocks, obtain a certain microrelief in the contact area, and try to reach largest bonding of the blocks.

It follows from the foregoing that the concept feature of the polygonal masonry under consideration is the use of large, heavy stone blocks weighing from several hundred kilograms to several tons. Such blocks do not require an additional fixation relative to each other while processing mating surfaces with a hammer and chisel. The Peruvian polygonal masonry is usually applied either for erection of load-bearing walls of the first floor or retaining walls[8] intended for slope strengthening or forming agricultural terraces. A dry polygonal masonry of small blocks does not provide adequate strength and stability of the structure.

The polygonal masonries of large blocks with large gaps were fabricated by simple transfer of sizes. More advanced polygonal masonries of large blocks tightly contacted with each other over a curved surface of large area required applying new, more complex techniques for block mating (see Sec. 2.3) as well as invention of special contrivances. The book describes two such possible contrivances – a topography translator (see Sec. 2.10) and a more complex 3D-pantograph[12] (see Secs. 2.1, 2.5-2.9). In addition, the book provides several methods to use these devices, it explains advantages and disadvantages of these methods, and their areas of applicability.

What does a stonemason has to continuously do while fabricating blocks fitted to each other through a complicated profile? The stonemason has to repeatedly apply one stone to another in order to determine the areas where the excess material should be removed. When the stones are small, it is easy to do.[6] But how to do this, and quickly and precisely, when the weight of the stones is hundreds of kilograms or even several tons? The suggested contrivances just allow us to solve this problem. It is no longer necessary to repeatedly move a heavy mating block during processing.

1.2. Construction material used

The main building materials of those years were boulders and blocks of rock of random (arbitrary) shape. As a rule, this building material did not need to be extracted (broken out in quarries), since it was initially presented everywhere in the form of multi-meter deposits of

Photo. 1.1. Machu Picchu, view from a nearby peak. Initially, a mountain top and/or a mountain slope was located at this site, which served as the material for the construction of the megalithic structure. That is why the stone buildings occupy the horizontal platform surrounded by the pointed peaks. No one dragged multi-ton stone blocks uphill, the material for construction was broken out right here on the spot. Photo by unknown author.

mountain debris formed at the foot of the mountains as a result of fallings and landslides. In most cases, this material did not even need to be transported from anywhere, since a construction took place usually at those locations where the stone material was already in great abundance.

If a megalithic structure was located on top of a mountain, then the construction material was taken (broken out) here on the site. That is why the tops (or sides) of the mountains, where, for example, the Machu Picchu (see Photo. 1.1) or Ollantaytambo (see Photo. 1.2) complexes of buildings are located, are cut off, while the tops of the neighboring mountains, where no one lives, are sharp (see also the plateau of the Fortress Sacsayhuaman in Photo. 3.19). Thus, stone megaliths were never dragged up a mountain but on the contrary, they were lowered down the mountain, if necessary (for example, when building terraces). Before construction, it was estimated – which rocks and in what volumes are available on the top and/or on the slope of the mountain. Building began only when the collected data corresponded to the intended plan of construction.

First, suitable boulders are being examined. The boulder is split along the crack while detecting visible cracks. If the boulder consisted of, say, two parts connected by a comparatively narrow bridge, the boulder was split across this narrow bridge. The boulder surfaces were roughly preprocessed with a hammer to obtain stone billets of a simpler shape. In particular, too prominent sharp corners were removed.

Photo. 1.2. Ollantaytambo, view from a nearby slope. The source of the material was a mountain top and/or slope cut off during the construction. The quarry was located right here on the spot. There was no need to drag the multi-ton blocks uphill to the construction site. The different stone materials used for the construction indicate that the top/slope of the mountain had rock outcrops of different rock types. Photo by D. Ovsyannikov, 2017, vsetravel.ru.

1.3. Comparative analysis of fabrication methods, pros and cons

In general, a polygonal masonry is not something unprecedented, such masonry has been used in Europe since antiquity.[5,13] In the Peruvian version, only the quality of the curved interfaces is striking, which is not easy to repeat even in our time.[14,15] The methods suggested by both the scientific-engineering community[6,14,15,16,17,18,19,20] and enthusiasts[21,22,23,24,25] for fabrication of the Peruvian polygonal masonry do not explain all the observed features and/or are often far from a reality.

The methods of polygonal masonry fabrication proposed by the author are based on the use of a reduced clay model and 3D-pantograph[12] (see Secs. 2.1, 2.5-2.9), topography translator (see Sec. 2.10), and replicas[16] (see Secs. 2.3, 2.5). The use of the topography translator, reduced clay model and pantograph provides not only the well-known unique appearance, high mating accuracy, and high quality of masonry of large blocks, but also allows to significantly increase the productivity of the builders. Only due to the high productivity it became possible to carry out the volumes of the polygonal construction revealed in Peru for an acceptable time, engaging a reasonable amount of labor force.

A distinctive feature of the polygonal masonry type under consideration and the methods of its creation is that a drawing with indicated there dimensions and tolerances is not required for precise fabrication of complex shaped stone blocks. When creating a wall by the method of

polygonal masonry, only wall thickness and height are held by selecting stone billets of appropriate sizes, and even then approximately. These features significantly speed up and simplify the process of creating structures based on polygonal masonry from stone blocks of arbitrary shape.

The main tools for stone processing in the suggested methods are a hammer and steel chisel (in practice, a set of chisels of different types[10,26] made of hardened steel). The hardness of granite, for example, depending on granite type makes 5-7 according to the Mohs scale. The hardness of the chisel body of hardened tool steel depending on the steel grade makes 6-7 according to Mohs. It would be fair to assume that the steel chisels used at the time of the construction of the Peruvian polygonal masonry were less hard in comparison to the modern ones and made, say, 5-6. Anyway, the hardness of both a modern steel chisel and ancient one does not exceed the hardness of granite, which is classified as a hard rock.

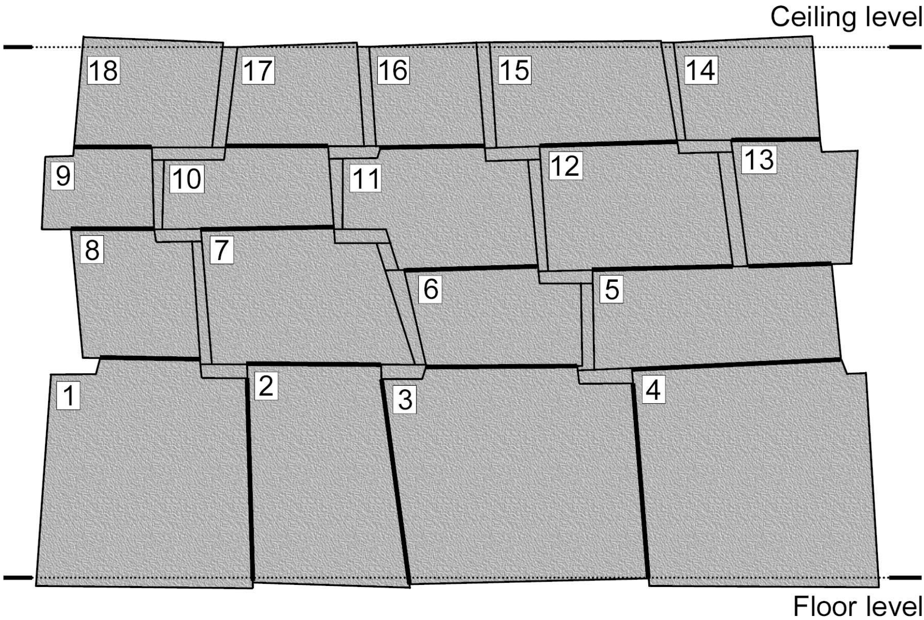
If the hardness of the chisel and granite are comparable, then the question arises: how can granite be processed with a steel tool? It is all about the fragility of stone materials. Processing with a steel tool is possible because granite despite its hardness is quite brittle. Processing a hard but brittle stone with even a softer steel tool is a local (point) chipping of the material with small pieces and not cutting/sawing it, as some believe. Stone material extracted from the core of a rock outcrop is usually softer and therefore easier to process.[10] However, such a stone gains strength and undergoes shrinkage within 2-3 years after its extraction to the surface.[10]

Thus, processing even such hard rocks as granite with chisels less hard than modern ones is quite feasible. It is just that softer chisels wear out faster and blunt faster that requires more frequent shaping in the forge. In this regard, during archaeological excavations of the sites of the large-scale megalithic construction, it is possible to discover remains of ancient forges on their territory. Note in conclusion that, besides the hammer and chisel, another simple tool needed to work effectively with stone blocks that many often forget about is a steel prybar (rockbar; see Sec. 3.1).

If we look at the shape of the stones of the Peruvian masonry closely, at the sites of their almost perfect fitting, then there is a feeling that the stones were not processed mechanically but were sculpted (see Sec. 3.1). In this regard, many researchers mistakenly decided that the stones were sculpted or cast from a certain plastic mixture – artificial granite, concrete, geopolymeric concrete, lime, rock softened by heating, and so on.[22-25] In this regard, the question immediately arises: why produce an expensive plastic mixture when there is a lot of ready-to-use material around – natural stone of arbitrary shape? What is even more unclear is: why should plastic mixture be given such complex shapes? Why not make a limited range of standard concrete blocks with locking elements, for example? Nevertheless, a sculpting really took place during the polygonal construction, but it was the sculpting of a reduced model of the future stone block from clay, not the sculpting of the stone block itself. Further, using a 3D-pantograph, the “sculpture” was simply transferred to a stone block with the enlargement set in the pantograph by means of a hammer and chisel.

There are other arguments against the plastic version. For example, the backside of many blocks is a ragged stone; there is no plastic mixture flowed into the interblock spaces inside the masonry; the stone blocks have veinlets and other features inherent in natural stone.[27] Unlike clay, concrete,[22] lime, and artificial granite are not suitable for hand modeling. Therefore, the blocks cast from these materials will have flat interface surfaces, as well as flat front and back sides, determined by the flat panels of the formwork used. Thus, if, for example, smooth L- or U-shaped recesses are present in the masonry, then, most likely, this masonry was not fabricated by the casting method generally accepted in construction (see also Sec. 2.2).

Any products obtained by casting/sculpting[25] shrink during the drying process. The shrinkage of modern concrete can reach 3%, lime shrinkage is noticeably greater. The casting shrinkage leads to casting size decrease, warping (shape distortion) and to cracking as a re-



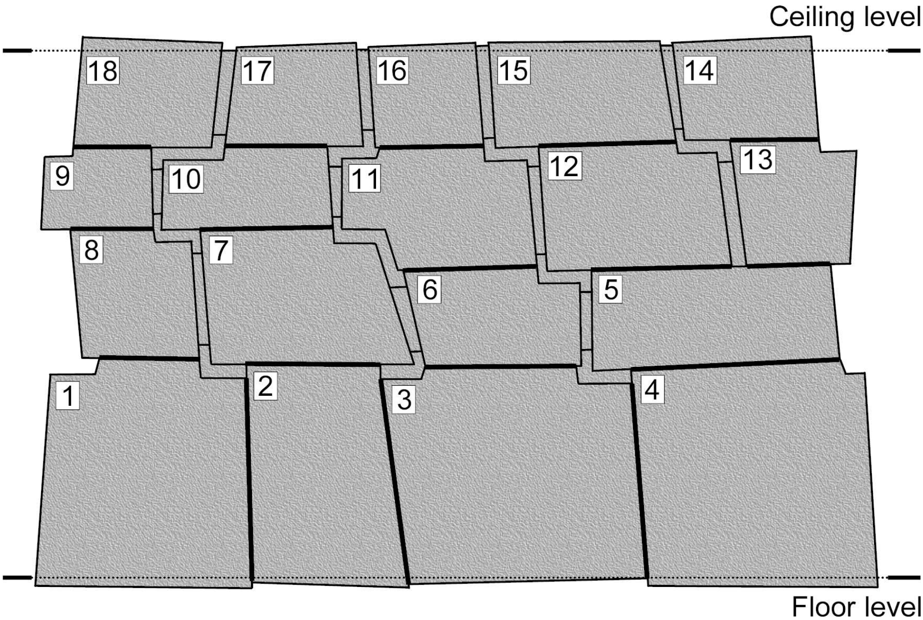
(a)

Fig. 1.1. The probable appearance of a casted polygonal masonry of blocks tightly-abutted to each other. The small blocks cast after laying the large blocks are intended for taking up the interblock gaps caused by a concrete shrinkage in the large blocks. Compensation by (a) quadrangular horizontal and vertical inserts, (b) L- and Z-shaped inserts. The abutment sections between the large blocks (shown with a bold line) are only depicted as rectilinear with zero gaps, in reality, these sections, strictly speaking, are curvilinear and the abutments always have an irregular gap due to the uneven shrinkage. The larger is the shrinkage coefficient and the larger is the block sizes, the wider are the gaps. Block deviations from the floor and ceiling levels due to a shrinkage are exaggerated for more clarity. The numbers show the installation order of the large blocks. The disadvantage of the masonry is a rather weak bonding of the blocks. This masonry may not be fully dismountable after erection.

sult. Thus, the presence of cracks can be one of the casting hallmarks. The shrinkage-induced casting size decrease, in turn, leads to interblock gaps. Since the initial shape of the blocks in the polygonal masonry is irregular, the shrinkage in addition turns out to be non-uniform. Accordingly, the gaps resulting from such shrinkage will be non-uniform too (nonparallel, see Ref. 23).

Thus, even if the blocks are cast sequentially one after another “in-place”,[22,23] waiting each time for the end of the shrinkage (ideal case), it is still not possible to completely eliminate gaps between the blocks. For the reinforcement-free concrete block with modest sizes of 50×50 cm (width × height) having typical average shrinkage coefficient of modern concrete of 1.5%, the gap between the blocks makes 7.5 mm (!). The larger are the sizes of the blocks, the greater is the value of their shrinkage, and, accordingly, the larger is the resulting gap.

The shrinkage can be reduced by using steel reinforcement and/or adding crushed stones of hard rock to the concrete mix. To hide the use of the crushed stones, the front side of the blocks should be covered with a plaster layer. Surely, there are also quite expensive shrinkage-free concretes (shrinkage coefficient 0.1%), but this invention is relatively recent. Thus, additional signs of the concrete technologies will be: reinforcement, crushed stone inclusions,



(b)

Continuation of Fig. 1.1.

a layer of plaster. When, according to a number of signs, we see that some blocks of a polygonal masonry are made by casting/sculpting of a concrete-like material, that, unfortunately, takes place in many known Peruvian monuments, before us are either a fake of recent times or unsuccessful repair/restoration.[28]

Fig. 1.1 shows an approximate view of the cast polygonal masonry of blocks tightly-abutted to each other. First, the large blocks are cast. After shrinkage termination, the polygonal masonry is assembled from the large blocks sequentially block by block (numbers in the figure show block installation order). After installing each course of the large blocks, small (compensatory) spaces between the large blocks are filled with concrete. Before casting, a thin layer of material is coated on the hardened concrete to prevent adhesion of the fresh concrete with the hardened one.[22,23] If necessary, the installation of large blocks resting on a still missing compensation insert (see, for example, block 18 in Fig. 1.1b) is carried out using small supporting stones. Note that the polygonal masonry obtained according to the described technology may not be completely dismountable in some cases.

It is seen from the presented procedure that the interface surfaces in the polygonal masonry obtained by the casting should be close to planes and the masonry itself should have a rather specific appearance (see Fig. 1.1). The large non-marginal blocks in such masonry are in a conditional contact with the neighboring large blocks with only two of their sides – the base and top face; the contacts of the rest (lateral) sides occur through the small blocks with a small shrinkage of their own. The small blocks are designed to compensate for the shrinkage-related size reductions and shape changes of the large blocks. Only this approach allows to reduce to a minimum (but not to zero) the gaps between the concrete blocks obtained by casting.

The disadvantage of the presented masonry is a rather weak bonding of the blocks. The insufficiently good bonding of the blocks results in separation of the masonry into loosely con-

Photo. 1.3. A section of the polygonal masonry with narrow vertical and horizontal inserts. Corner of Maruri and Qapchikijllu streets in Cusco. Photo by unknown author.

nected "posts".[9] In Fig. 1.1, such posts are formed by the blocks 1-8-9-18, 2-7-10-17, 3-6-11-16, and 4-5-12-13-14-15. Moreover, local posts (blocks 12-15 and 13-14) may form within the posts. All this affects the strength and stability of the proposed type of the polygonal masonry negatively.

The more sides a large concrete block has, the more the compensating inserts are required, accordingly, the more complex the formwork used is. Since there are no triangular blocks in the Peruvian polygonal masonry, the simplest shape of the block in this case is a conditional quadrilateral (more precisely, a conditional parallelepiped). The conditional quadrilateral occurs if one ignores changes in the shape of a large polygonal block related to the recesses for the compensation blocks in its body.

Photo. 1.3 shows a section of stone polygonal masonry with narrow vertical inserts[29] at the corner of Maruri and Qapchikijllu streets in Cusco. It could be assumed that this masonry was fabricated by the casting method discussed above. However, unlike the masonry shown in Fig. 1.1a, the presented section is the only one and no longer repeats along the wall. On the other hand, if the stone blocks of this masonry were fabricated mechanically, the masonry would not have the narrow vertical inserts. In case of a mechanical processing, the lateral sides of the stone blocks would simply abutted directly to each other. With that, it would only be necessary to ensure the proper block bonding. In the case of a mechanical processing, the

masonry shown in Photo. 1.3 can only contain quadrangular inserts contacting their four sides with four adjacent blocks. However, the masonry style of the rest part of the wall is completely different – the blocks having shape close to parallelepiped are laid in courses, each course consists of the blocks of approximately the same height.

Nevertheless, the mating of the stone blocks shown in Photo. 1.3 can occur while processing mechanically if a wall construction is carried out from both directions towards each other using standard-sized blocks. In this case, a small gap may form at the meeting site. Typically, the masonry of identical blocks is started from a corner and closed with the similar narrow inserts, if necessary, somewhere on the backside or a lateral side of the building in an inconspicuous place. However, the masonry section in question consists of unequal length blocks and is located on the corner of the building, moreover, on its facade side. Besides that, the narrow horizontal inserts (leftmost) cannot be justified either by a casting or mechanical treatment. It follows from the conducted analysis that the quadrangular inserts, the narrow vertical and horizontal inserts, most likely, had to be embedded in this masonry site during some repair related to elimination of a crack, chippings/crumbling of the blocks. The presence of a thick layer of mortar confirms this assumption additionally.

The design shown in Fig. 1.1a uses the narrow quadrangular inserts in contact with three adjacent blocks. In the design shown in Photo. 1.3, the contact of the quadrangular inserts occurs with four adjacent blocks. The design shown in Fig. 1.1b uses the L- and Z-shaped inserts that contact four adjacent blocks. The L- and Z-shaped inserts provide greater strength and stability for the building. However, the chance is higher that the building turns out to be partially dismountable while using such inserts. Thus, according to the proof by contradiction presented above, one can draw the following conclusion. Since no masonry similar to the one shown in Fig. 1.1 has been found in Peru, the methods of casting into a formwork were not used for fabrication of the walls from the polygonal blocks tightly-abutted to each other.

Besides the mechanical treatment of stones by means of a hammer and steel chisel, the method is also proposed in the book that allows casting large polygonal blocks into a mold (see Sec. 2.2). In this case, the tight abutment of polygonal masonry blocks is achieved due to high casting accuracy (small shrinkage). According to this technology, the typical signs of the casting are: a solid/hollow core made of cheap concrete-like material and a comparatively thin shell made of more expensive artificial granite. The main disadvantages of this method when used in construction are: a limited weight load that the shell can withstand, high complexity and laboriousness, as a consequence, excessive cost.

As for a chemical[20] or heat[30] influence on a natural stone like granite, limestone and some other rocks, it results in formation of a nonuniform surface layer with degraded mechanical properties. A polygonal masonry assembled of such stone blocks will disintegrate quickly because of crumbling of the stone blocks at their contact points. As a result of the disintegration, the blocks in such masonry will move apart soon and noticeable gaps will appear between them.

1.4. Historical, economic, political, civilizational and other aspects

By the time the Europeans conquered the South America, the Indians did not know either iron tools or a wheel or a potter's wheel, did not have draft animals, did not own the technology of brick firing, and did not possess a written language. Peru is a mountainous country, thus, it is impossible to grow large volumes of agricultural products there simply because of an acute shortage of sown areas suitable for agriculture. The acute shortage of agricultural land, in fact, became the reason for the large-scale construction of the terraces[31] on the mountain slopes, especially at that moment of the Peruvian history, when the arrived Europeans have launched the large-scale mining of gold and silver. A town (civilization), let alone an empire, cannot arise without a developed agriculture. The developed agriculture implies the food production in commodity quantities.

On himself, a peasant is able to plow a vegetable garden from which only his family will feed. To feed several families of townspeople, the peasant needs to use agricultural machines of those years – horses or oxen, as well as agricultural implements to those “machines”. In order to deliver food and raw materials for craftsmen in the town, transport machines of those years – carts and wagons drawn by horses or oxen, at least mules and roads were required. Agricultural and transport machines of those years – horses need “fuel” to work, a lot of fuel. Therefore, a part of the scarce land will have to be taken away for grazing and for fodder grain cultivation.

Since the towns in Peru could not self-originate for the above reasons, then an empire could not arise in Peru. The Inca Empire is a fiction, a myth, it never existed (see Sec. 3.5). Under certain natural and climatic conditions, human settlements in the form of a village can reproduce themselves over and over again indefinitely. The first towns in Peru appeared only when European settlers arrived there. The settlers brought the iron tools, wheeled transportation, horses, cereal crops, modern for that time weapons, agriculture and handicraft technologies, written language; established own laws, introduced money and commodity-money relations, built the roads and bridges; had ordered the religious beliefs of the Indians gradually; being the victors, they composed a nice history of Peru to form the nation state.[32,33]

Taking into account the above arguments, one can conclude that only the builders who came from Europe could erect the polygonal structures under consideration in the book (see Secs. 3.5, 3.6). Unlike the Indians, these builders had all the necessary tools, mechanisms, and skills for the large-scale construction. The marks of this large-scale stone construction are visible everywhere – Catholic cathedrals, monasteries, palaces, villas, a lot of urban and industrial buildings, bridges, roads, water lines.[34] In particular, the famous Fortress Sacsayhuaman is an example of early star fortresses that survived to our time (see Sec. 3.6). As machines coping-scaling three-dimensional objects are known since the beginning of the 18th century (see Sec. 3.4), a part of the polygonal structures under consideration should be dated around this time.

Any large-scale construction always implies the existence of an economy corresponding to this scale. Therefore, the book additionally explains what the economy of Peru was based on in those years (see Sec. 3.5). The impressive scale of the megalithic construction on the territory of Peru suggests that the Vatican has tried to create here another unique world religion, another world religious center for the entire region of South America (see subsection 3.5.1). However, after many years of hard work, this project was abandoned.

Subsection 3.7.1 analyzes the so-called “tired” stones. The tired stones are meeting along the path leading from a quarry to the construction site of the Fortress Ollantaytambo. The examination of these stones showed that they were planted by unknown falsifiers long after the construction of this complex had been stopped. The “scattering” of the tired stones was needed to assert the myth that the Ancient Incas, as Ollantaytambo builders, were able to move stone blocks weighing several tens of tons along the mountain roads of those years over a distance of five and more kilometers, knowing neither iron, nor wheels, nor lifting mechanisms, without having draft animals. While, in fact, all the stone used for construction was taken and quarried right here at the construction site and/or in close proximity to it (see Sec. 1.2), and not at all the Ancient Incas, if they played any role in the Ollantaytambo construction, has an auxiliary role of laborers only.

In subsection 3.7.2, the theme of the “tired” stones is generalized to the unfinished Aswan Obelisk and the Baalbek monoliths-parallelepipeds. It turned out that several “incredibly ancient” megaliths in Ollantaytambo including one of the tired stones bear exactly the same traces of processing with steel tools as the “incredibly ancient” Aswan Obelisk. Analysis of the traces found on and around the Aswan Obelisk made it possible to explain how this obelisk was formed and with what tools. The disappointing conclusion that the author comes to in this book section will upset those who are interested in the Ancient Egypt – the unfinished Aswan Obelisk, alas, is a fake. Due to the similarity in a number of features of the Baalbek monoliths-

parallelepipeds with the Aswan Obelisk, these monoliths-parallelepipeds are also fakes.

Sec. 3.8 shows that some “Ancient” Egyptian statues of pharaohs could be made using the casting technology described in Sec. 2.2. Also, Sec. 3.8 explains how, by performing a slight modification of the 3D-pantograph design, it is possible to fabricate the “Ancient” Egyptian statues of pharaohs, which left and right halves have a high enough degree of mirror symmetry. In this regard, an analysis of the symmetry and fabrication process of the Queen Nefertiti bust was carried out. Subsection 3.8.1 provides a reasoned justification that the world-famous bust of Queen Nefertiti is a fake. Section 3.9 suggests what the “mysterious” Sabu disk was and what it was served for.

4. Discussion

Among the materials related to the topic, work 24 should be noted. The author suggested to use a reduced gypsum model of a stone block and to perform transferring and scaling of a complicated surface geometry with a caliper by several reference points. The gypsum model is usually required to avoid wearing of the original clay model while producing copies. This problem does not arise while fabricating blocks for the polygonal masonry. Moreover, in the case when the block clay model is formed initially by a stone billet of arbitrary shape, it is used just once and then thrown out (or serves as a core for a new model). Thus, in order to reach the required result, possessing only a clay model of the block is quite enough.

The transferring process of a complicated surface geometry and its scaling by few reference points using the caliper is very time-consuming and inaccurate. However, this process ceases to be time-consuming and inaccurate if we apply the 3D-pantograph instead of the caliper. Analysis shows that in most cases, first, a reduced clay model is created by a stone billet of an arbitrary shape using the 3D-pantograph. Then, the regions are cut out in the clay model of the block for interfacing with neighboring blocks. After that, a model wall is assembled of the model blocks. After drying, the wall is disassembled, and the interface regions of the model blocks are transferred to their stone billets by means of the 3D-pantograph.

Technically, the topography translator is comparable in terms of complexity to a 2D-pantograph which creation dates back to the beginning of the 17th century. The knowledge accumulated in the field of mechanics and the technology level achieved by the beginning of the 18th century could quite allow to design and build the 3D-pantograph suitable for construction needs. Thus, the most complex polygonal masonry obtained with the 3D-pantograph by clay models should be dated to the beginning of the 18th century, and the simpler ones obtained with the topography translator should be dated to the beginning of the 17th century.

The Fortress Sacsayhuaman was built by the Spaniards no earlier than the 17th century, since its very appearance and the defense concept adopted at that time closely related to the small arms available at that moment clearly indicate this. No earlier than the beginning of the 18th century, the polygonal bas-reliefs and the polygonal giant Face Towers of the Cambodian temple complex Angkor as well as a number of the “Ancient” Egyptian giant statues known for their symmetry should be dated, since the 3D-pantograph was needed to create all of these monuments.

In fact, the means for creating the most complex polygonal masonry proposed in this book are devices (contrivances) and methods that have been reinvented by the author. A full-scale experiment should show how suitable these means are in practice for reproducing the polygonal masonry of the type under consideration. The author's correctness could also be confirmed by the discovery of written sources containing descriptions of contrivances and construction techniques similar to those presented in this work.

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Besides answering the questions posed in the title, the book presents a number of interesting results obtained in passing. Since the 3D-pantograph allows to create three-dimensional objects with a high degree of mirror symmetry, the author has evaluated the symmetry of the Queen Nefertiti bust and analyzed the process of its fabrication. In the course of the conducted research, facts were found that prove for certain that the world-famous bust is forgery. Strikingly, the so-called “tired” stones in Ollantaytambo, the unfinished Obelisk in Aswan, and the Baalbek monoliths reveal a number of similarities. A careful examination of these “incredibly ancient monuments” results in a disappointing conclusion that they are all fakes. In particular, it turned out that the “tired” stones were scattered by unknown falsifiers along the road supposedly leading from a quarry to the construction site much later than the building time of the fortress-temple Ollantaytambo itself. By analyzing the characteristic traces left by the falsifiers on the surface of the Aswan Obelisk and around it, it was possible to understand and reconstruct how and with what tools this obelisk was actually formed. At the end of the book, an interesting idea is expressed explaining the functional purpose of the “mysterious” Sabu disk, which has been exciting the minds of Egyptologists around the world for decades.

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